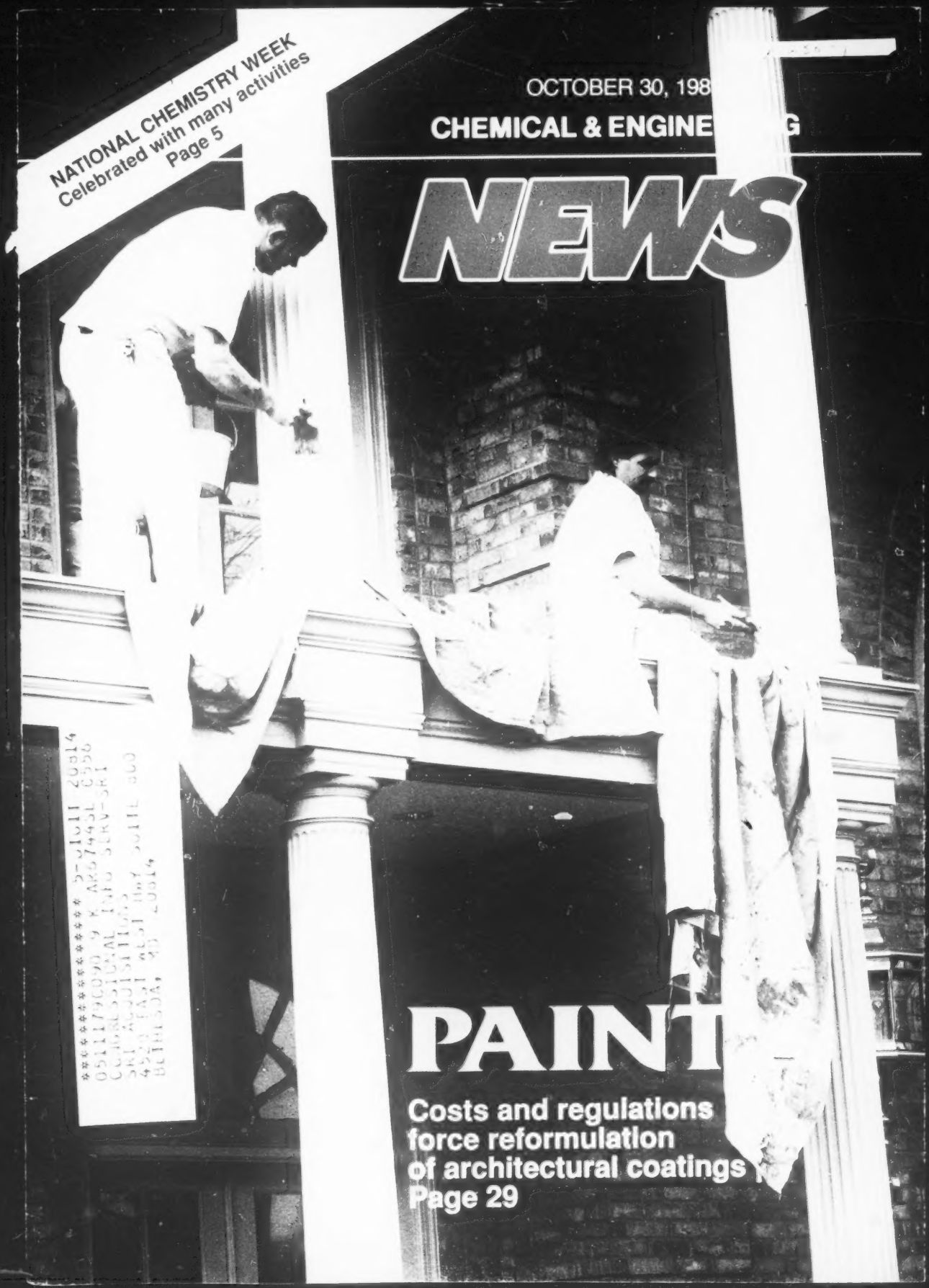
OCTOBER 30, 198
CHEMICAL & ENGINE G

NEWS

NATIONAL CHEMISTRY WEEK
Celebrated with many activities
Page 5



PAINT

Costs and regulations force reformulation of architectural coatings
Page 29

CHEMICAL & ENGINEERING
NEWS
Volume 67, Number 44
CENEAR 67 (44) 1–88
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OCTOBER 30, 1989

News of the Week

■ **The huge explosion and fire last week at Phillips 66's Pasadena, Tex., plant killed and injured scores of people, took out of commission one of the world's largest polyethylene facilities.** Page 4

■ **After months of planning, ACS's National Chemistry Week is under way with a variety of activities around the nation.** Page 5

■ **Participants in House hearing condemn awarding of performance bonuses to contractor at Department of Energy nuclear arms plant, despite environmental, safety, and health violations.** Page 5

■ **A new drug of abuse, a smokable form of methamphetamine called "ice," is racking Hawaii and experts fear it will become the "drug of the '90s."** Page 6

■ **Chemical industry faces cyclical downturn after long string of earnings gains, as several firms register third-quarter declines.** Page 6

Business

Some signs of an economic slowdown are worrying European chemical industry executives, although their mood is still generally upbeat. **Page 9**

Government

Senate's reconciliation budget kills number of provisions sought by chemical industry and ACS, including R&D tax credits. **Page 14**

Alternative fuels and alternative-fueled vehicles are focus of study to be conducted jointly by nation's largest automakers and 14 major oil refiners. **Page 17**

Science/Technology

Silicon microphysiometer developed by Molecular Devices Corp. gives sensitive measures of metabolic responses of cells. **Page 20**

Great Lakes ecosystem needs immediate cleanup action according to recent study. **Page 22**

Booklet on values, conduct of scientists produced by National Academy of Sciences in effort to provide professional context for graduate students, faculty members. **Page 24**

This year's measurements of Antarctic ozone hole indicate depletion matches record set in October 1987. **Page 24**

Books

"**High Tech Holocaust**" eschews abuse of modern technology, but provides little vision or direction for readers. **Page 65**

Cover: Photo courtesy of Porter Paint Co.

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Product Report

Architectural paints continue to make up nearly 50% of all paint shipments, but environmental regulations and raw material costs are forcing manufacturers to search for ways to reformulate them. **Page 29**

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LETTERS

CHEMICAL SAFETY

Sodium nitrite

SIR: We narrowly averted an explosion in our heating and cooling plant due to the improper use and disposal of a fire extinguisher agent and an oxidizer called Vaporene N-90. The oxidizer, packaged in a polyethylene bag-lined, standard open-head 300-lb-size fiberboard drum, is used for corrosion control in a recirculating, chilled-water system. Workers were removing metal pipe hangers when a piece of hot metal ignited the drum. The worker on fire watch had difficulty extinguishing the fire and used two 20A120BC dry chemical extinguishers. Workers cleaned up the fire scene by placing the spent fire extinguishing agent and the remains of the Vaporene drum inside a larger fiberboard drum. We noticed that the drum felt unreasonably warm and suspected that a chemical reaction was taking place within the drum. The drum of material was removed from the building, and the contents were hastily separated and quenched with water.

After the fire had been extinguished, we checked the material safety data sheet (MSDS) for Vaporene N-90 and found that it is composed of sodium nitrite and sodium tetraborate and is incompatible with ammonium salts. The label on one of the fire extinguishers listed its contents as ammonium phosphate. The second extinguisher's contents were determined by calling the manufacturer and requesting an MSDS. The MSDSs for both extinguishers did not list incompatibility with sodium nitrite. The explosive danger of sodium nitrite was demonstrated at Berkeley (C&EN, Oct. 11, 1982, page 29) where 3 lb did $200,000 damage.

Mark T. Jensen, *Microbiologist*
Steve Rod, *Safety Technician*
Department of Agriculture
Ames, Iowa

Communication challenge

SIR: Ann Thayer's cover story, "Alar Controversy Mirrors Difference in Risk Perceptions" (C&EN, Aug. 28, page 7), addresses an issue that will profoundly influence how billions of taxpayer's dollars will be spent in the future. Two important factors relative to how we approach this issue were not addressed in the article.

The article stresses the importance of the role of industry and government in communicating more effectively with the public about its perception of chemicals in the environment. We in academia must also share in this responsibility. Indeed, our involvement is essential. The academic membership of the Council for Chemical Research is taking an active role in this arena and there are signs that the American Chemical Society is beginning to do likewise.

The article acknowledges that the public can be very much influenced by the media and refers to the "60 Minutes" segment on Alar that aired May 14. What the article does not state is that the media can grossly distort scientific arguments as was done with the material presented from Ed Bradley's interview with Bruce Ames on this "60 Minutes" segment. For many Americans, programs like "60 Minutes" are biblical truth—as are pronouncements made by admired performers such as Meryl Streep. Communicating with the public under these circumstance is a real challenge.

Fortunately, all is not lost. One of the media world's most trusted personalities, Walter Cronkite, has just completed a superb television tape, "Big Fears, Little Risks" (Film Counselors, NYC), which attempts to present a rational discussion of risk assessment. The public may not listen to the presidents of ACS and Du Pont, but they do listen to Ed Bradley and Meryl Streep. Fortunately, they will also listen to Walter Cronkite.

J. Ivan Legg
Dean, College of Sciences and Mathematics
Auburn University

Arms control negotiations

SIR: Regarding the recent pronouncements of progress toward the reduction of the chemical weapons stockpiles of the U.S. and the U.S.S.R. (C&EN, Oct. 2, page 6), it is useful to remember that the 80% reduction generously offered by President Bush is already required under Public Law 99-145. This law requires that the Department of Defense destroy most of the U.S. stockpile by 1997. To this end, technology demonstration and prototype work are currently under way at Johnston Atoll and Tooele Army Depot.

That the President could use a mandated unilateral stockpile reduction to induce the Soviets to make their own cuts may reveal something of the nature of superpower arms control negotiations.

David N. Clark
Plain City, Ohio

European Execs Grow Concerned Over Outlook for Chemical Industry

Although generally optimistic about 1990s, speakers at marketing research meeting see worrisome signs, question how long before a downturn

Patricia L. Layman, C&EN London

The mood at this year's annual meeting of the European Chemical Marketing Research Association, held earlier this month in Paris, was essentially upbeat. But that nagging question—how long can the good times last?—had become strong enough to give the meeting a more reflective atmosphere than in the past few years.

Bernard Azoulay, vice president of international operations for Atochem, the chemicals arm of France's Elf Aquitaine group, set the stage in his keynote speech. "The chemical industry has enjoyed an exceptionally long and profitable cycle, something that the historians may call one day the roaring '80s of the chemical industry," he said. "But now, everybody in the industry is concerned because of some worrying signs which appeared during the last months, and particularly the sharp decrease of the prices of some commodity chemicals."

As he saw it, the crucial question is whether the chemical industry will be able to cope with the slowing down or recession of the European economies, and minimize the impact on its profitability. "From what we have seen during the last months, particularly the erratic variations of the prices of some chemicals, we are not really prepared for that," he argued.

The general outlook for the 1990s is actually quite favorable for the industry. According to Kjell Andersen, special economics adviser to the Norwegian delegation to the Organization for Economic Cooperation & Development, Western European economies will grow at an annual rate of 3 to 4% for the 1990s, a bit more than in the past 15 years. Japan's economy will continue to grow 4% or more per year, and the U.S.'s, about 3% per year.

Moreover, oil prices—increases in which hurt the chemical industry in the mid-1970s to the early 1980s—look to be stable into the next decade. That was the forecast of Silvan Robinson, chairman of the energy and environmental program of the Royal Institute of International Affairs, London.

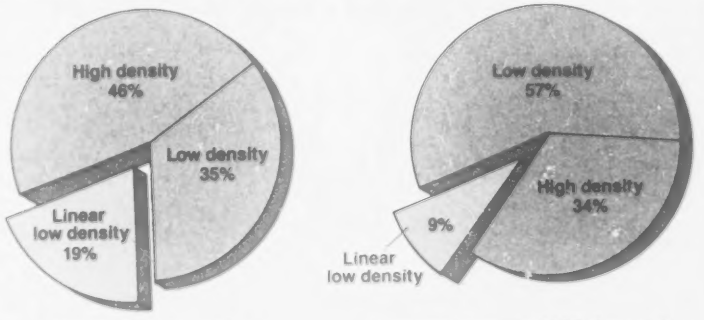
Rising demand could force oil prices to rise, he conceded. But environmental questions, which "will dominate the agenda for the oil industry in the next 10 years," probably will curtail demand to the extent that supplies won't be pushed enough to justify price hikes.

Instead, key to the industry's performance over the next few years, Atochem's Azoulay and other speakers agreed, is the specter of overcapacity in several important chemical industry products.

Azoulay cited ethylene as an example. Cracker capacity in Western Europe is expected to climb from the current level of just over 14 million metric tons per year to about 20 million metric tons by the year 2000. If there is sustained strong economic growth, he predicts, production by that year would amount to about 18.5 million metric tons and capacity use to 92%. However, if Western European economies were to slide into recession, production would be only about 15 million metric tons per year and capacity use a nonprofitable 75%.

Polyethylene consumption also has climbed markedly in the past few years. The polyethylene market in Western Europe is just slightly smaller than that in the U.S.—7.65 million metric tons in 1988, compared with 8.25 million metric tons in the U.S. The product mix in Eu-

Linear low-density polyethylene accounts for 19% of market in U.S., only 9% in Western Europe



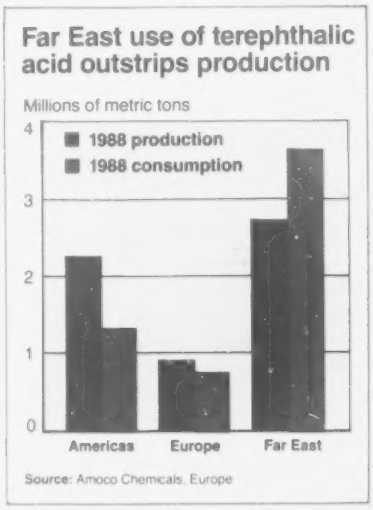
Source: Atochem

rope hasn't shifted so much as that in the U.S., where linear low-density polyethylene accounts for nearly one fifth of the market, perhaps because European producers have been preoccupied with restructuring and slashing capacity. Low-density polyethylene continues to dominate the West European market, pointed out Philippe Goebel, director of polyethylene for Elf Aquitaine Group's chemicals unit, Atochem.

"Over the next two years, I am not pessimistic," said Pierre-Yves Masson, president of London-based Shell Chemicals International Trading Co. "There won't be a big drop in most commodity petrochemicals. After that, however, I'm very concerned." Of the announcements of new crackers to be built, he added, "there is more than a 50% chance that these plants will be built. If we go into a recession, then we will go into the same position as in the early 1980s."

Polypropylene and terephthalic acid also were cited as having the potential for significant overcapacity by speakers at the meeting. Forecasts for polyvinyl chloride, on the other hand, showed its capacity as tracking closely with consumption through the end of the decade.

True to the theme of the conference—strategies for world markets—speakers agreed that these problems in overcapacity would be global. However, Masson pointed out, although Western Europe in the year 2000 "will remain a net exporter of petrochemicals and polymers," its share of chemicals trade is shrinking. Many of its traditional customer countries, such as those in Southeast Asia, are building their own capacity. And other countries have become or are working to become strong exporters, in competition with European producers.



Perhaps the best example of a newly emerged global competitor in the chemical industry is Saudi Arabia, under the aegis of Saudi Arabian Basic Industries Corp. (SABIC). In the early 1980s, SABIC disclosed its plans for the first phase of entering the chemical industry, plans that many in the U.S. and European industries discounted at the time.

However, results have been dramatic. SABIC, which now ranks itself as 25th in the world among petrochemical companies, has spent some $12 billion in a variety of plants and complexes. With SABIC accounting for the majority of Middle East production, the Middle East now accounts for 9% of world ethylene glycol capacity, 5% of ethylene, 5% of high-density polyethylene, and 4% of linear and conventional low-density polyethylene. The Middle East also accounts for 9%, 4%, and 5% of world capacities of methanol, ammonia, and urea, respectively, said Yousef Al-Zamel, director of chemical sales for SABIC Marketing Ltd. Most of the ethylene is used in downstream plants, he added, "to gain value-added products for use in local markets and for export."

In its next phase, SABIC plans to spend $4 billion on increases in capacity from debottlenecking, flexible-feedstock crackers, downstream derivatives, and fertilizer plants.

"Much of our effort in the next decade will continue to be in joint ventures with outside—possibly European—companies," added Al-Zamel. "We see Europe as an important market for our chemicals, but this should not become too heavily emphasized since our efforts will also concentrate on sales to our natural markets in the Middle East and Far East."

The Far East, in particular, remains a solid market for western petrochemicals, despite indigenous industry buildup. For example, according to John Umfreville, business development manager for Amoco Chemicals, Europe, the industry is seeing a buildup of capacity in terephthalic acid used to make polyester. Because some 79% of the 10.4 million metric tons of polyester consumed annually is used to make fiber, the primary market is the Far East, seat of the world's textile industry.

The building of terephthalic acid capacity in the Far East will inaugurate a period of global oversupply, Umfreville predicted. However, with demand growing for the acid at 6.4% per year between now and the end of the century, the Far East will continue to be a net importer of terephthalic acid because of continued investment in polyester capacity.

The markets for engineering and high-performance plastics, however, are predominantly in North America (37% of world demand) and Western Europe (34%). Japanese consumption accounts for 20% of world markets, and the rest of the world, 9%, said Dietrich Fleischer, manager for polymers R&D at Hoechst A.G. Not surprisingly, the major suppliers are U.S. and West German companies.

The annual growth rate of engineering plastics—including polyacetals, polyphenylene oxide, and polycarbonate—ranges from 5 to 10%. Those for high-performance plastics—such as polyarylate, polysulphone, polyether imide, polyether ketone, and liquid crystal polymers—are in the 15 to 25% per year range, he added. Global demand for both classes of these plastics was about 1.99 million metric tons in 1988, and is expected to reach nearly 3 million metric tons by 1995. □

GE dominates sales of engineering, high-performance plastics

Millions of metric tons, 1988	GE Plastics	Hoechst	Bayer	Du Pont	BASF
Americas	315	75	70	135	20
Europe	125	155	140	45	140
Asia/Pacific	70	95	15	30	15
TOTAL	510	325	225	210	175

Source: Hoechst

Demand Puts Paint Sales At Record Levels

Glidden/ICI Paints photo

Marc S. Reisch,
C&EN Northeast News Bureau

Increased demand again put paint sales at record levels as producers shipped more than 1 billion gal of paint and coatings in 1988 valued at more than $11 billion.

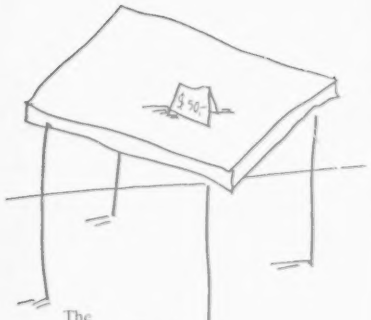
An analysis of government statistics providing a profile of the paints and coatings industry follows beginning on page 30. Those statistics show that though architectural paints continue to make up nearly 50% of all paint shipments, they represent only 40% of the value of all paints and coatings shipped.

Manufacturers of architectural coatings, the focus of C&EN's examination of the paint market beginning on page 37, are under increasing government pressure in busy metropolitan areas to reduce the volatile organic compounds (VOCs) contained in their coatings formulations. Partly as a result, alkyd paints have become increasingly less important in architectural coatings. However, there may be new life in alkyd coating systems. Recent research into a natural reactive diluent derived from the seed of an African plant, *Vernonia galamen-sis*, promises to permit the formulation of alkyd coatings that contribute virtually no VOCs as they cure.

Beginning on page 50, the growing problem of the rising cost of formulating and labeling products (especially when the prices of many of the raw materials going into low-profit-margin architectual paint rise faster than consumer prices of paint) is explored. Not enough paint retailers agree with Robert E. Champagne, president of Porter Paint and chief executive officer of Courtaulds Coatings N.A., who says, "Consumers can't afford to buy less than the best. But the industry has been in the business of selling cans of paint and not the product they contain. That has done a lot of damage."

Rohm & Haas is now trying to focus do-it-yourselfers on more expensive, quality paints via its Paint Quality Institute. But though some would like to see architectural paint quality and the prices that consumers willingly pay increase, many in the industry doubt whether that will happen soon. Paint formulators continue to look for ways to cut cost.

Beginning on page 54, the role of colorants and additives in cutting costs is examined. Paint makers can reduce their costs and also get a consistently good product by depending increasingly on color dispersant manufacturers for color-



The 'Marke-Table' by noted Swiss cartoonist and satirist Louis Mermet.

ants rather than making their own. And should the emphasis on quality increase and prices in general rise for architectural coatings, industry suppliers are ready with a number of additives to improve paint quality and performance.

Shipments up 3.7% last year

U.S. paint makers shipped close to 1.1 billion gal of paints and coatings in 1988, according to the Department of Commerce. That volume of shipments marked a strong 3.7% increase over the previous year for an industry that more frequently turns in 1 to 2% annual growth rates. In terms of value of shipments, the industry did much better in 1988. The value of shipments rose 10% to $11.1 billion in 1988 compared with the previous year.

Increases in shipment values, however, must take into account the rise in raw material prices that paint makers had to pass along to consumers in 1988. The Department of Labor's producer price index showed that paint materials prices increased 7.8% in 1988 compared with 1987. Clearly then, the increase in shipment value can't have gone entirely into the paint producer's pocket.

Overall, then, the paint industry's performance pretty much parallels that of the U.S. economy, whose gross national product grew at a constant dollar rate of 3.9%, according to the Department of Commerce.

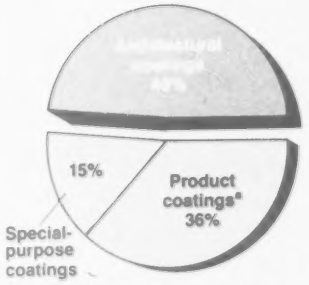
This year, however, promises to be slower overall. Shipments for the first six months of 1989 at 640 million gal have lagged the comparable period of 1988 by 2.1%. Some industry observers cite wet weather in the Northeast as a reason for a decline in exterior architectural and maintenance coatings sales for 1989. But the value of shipments of these coatings increased 6.4% during this period, again mainly because of raw material price increases that have been passed along to the consumer.

As increases in raw material prices continue to put pressure on paint makers, and as changes in the regulatory environment, particularly in relation to volatile organic compounds, add more pressure, the industry continues to contract. Strong regional and national manufacturers have the edge. According to Stephen Einhorn of Einhorn Associates, Milwaukee, Wis., the competitive balance is shifting in favor of the larger firms.

Two of the larger acquisitions to take place this year, Whittaker's coatings and chemicals division by Sherwin-Williams for $147 million and Reliance Universal by Akzo for $275 million, represent about 10% of the $4.5 billion industrial product coatings market, notes Einhorn. He figures that the strategy of many of the larger paint producers is to improve market share even though earnings are barely satisfactory. In the long term, he says, they do expect above average earnings.

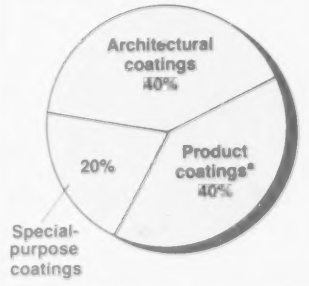
Other acquisitions that have taken place this year include Courtaulds' $282 million purchase of Product Research & Chemical, a sealants and high-performance coatings manufacturer, Dainippon's purchase of resin producer Spencer Kellogg,

Architectural coatings dominate shipments...



Total 1988 shipments = 1.09 billion gal

...equal product coatings in value of shipments



Total 1988 value = $11.1 billion

a Original equipment manufacturers
Source: Bureau of the Census

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Nippon Oil & Fats' $25 million purchase of the U.S. paint division of Grow Group, and the $16.5 million purchase of Whittaker's Ram division by Lilly Industrial Coatings. Recently PPG Industries announced plans to purchase Olympic and Lucite from Clorox for $130 million. Kline & Co., the Fairfield, N.J., consulting firm, says its worldwide acquisition tracking service lists 25 paint and coatings combinations in the period between January and July 1989.

The number of U.S. paint producers continues to decline, according to James A. Rauch of Rauch Associates, Bridgewater, N.J., which produces the Rauch Guide to the U.S. Paint Industry. In 1967, 1459 companies produced paint; in 1982 there were about 1170 paint producers. Today he suspects the number is closer to 900. Mergers and acquisitions activity within the paint industry over the past 10 years has accelerated, both Rauch and Einhorn point out. Both agree that the number of active paint formulators will continue to contract.

Two major reasons for the large number of mergers and acquisitions are the increase in paint ingredient costs and the cost of reformulating and relabeling to conform to conflicting local government regulation. Other reasons include intense industry competition, low profit margins in many but the most specialized applications, and globalization efforts by some large paint makers as they purchase smaller companies and thus increase market share. Another factor is the continuing interest by foreign paint producers in securing and increasing their U.S. market share while the dollar is still attractively priced and the U.S. government is not intervening in acquisitions by foreign-based operations.

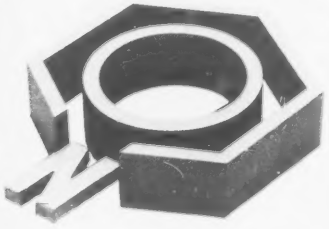
A 1988 profile of the industry based on Bureau of the Census figures shows that architectural coatings, which include both interior and exterior house paints, continue to make up almost half of all paint sold in the U.S. Product coatings for the original equipment market (OEM), which includes automotive and appliance coatings, accounts for some 36% of U.S. paint volume. And special-purpose coatings comprise about 15% of total paint shipments. This category includes large-volume maintenance items, automotive refinishing, and coil coatings.

Shipments of architectural coatings in 1988 increased 0.9% to 532 million gal. The value of those shipments, however, rose 3.8% compared with the previous year to $4.38 billion, and the unit price per gallon rose 2.7% to $8.23. Architectural coatings shipments showed some resilience in 1988 despite the decline in housing starts and new housing units put in place for the year.

Product coatings shipments for the OEM sector rose again in 1988, up 2.1% from 1987 to 393 million gal. The value of those shipments rose 16% from the previous year and the unit price increased 11% to

PRODUCT PROSPECTUS

Pyridine
and Derivatives



Pyridine and its derivatives offer new ways to improve processes, develop new applications or intermediates, or create entirely new technologies in pharmaceuticals, agricultural products, chemical processing, textiles, and rubber chemicals.

The people to talk to for pyridine chemistry

NEPERA

Nepera, Inc.
Route 17
Harriman, NY 10926
(914) 782-1200

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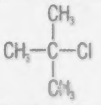
Alkylchlorides

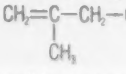
n-Butylchloride
(1-Chlorobutane)

$CH_3-CH_2-CH_2-CH_2-Cl$

tert.-Butylchloride
(2-Methyl-2-chloropropane)



Methallylchloride
(3-Chloro-2-Methyl-1-Propene)



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$11.35. A portion of that increase in shipment value and unit price may be related to higher U.S. passenger auto, truck, and bus sales in 1988. Automakers, as well as other OEM manufacturers, are bearing the cost of reformulated and, in many cases, higher solids paints, to bring their plant emission outputs into conformance with VOC regulations.

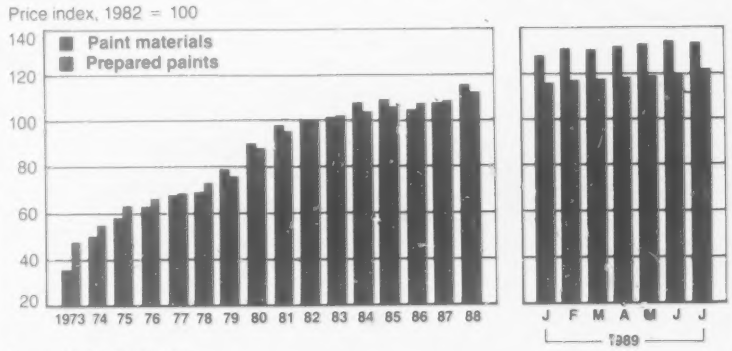
Special-purpose coatings shipments and total value also increased in 1988. According to government figures, special-purpose coatings shipments increased 19% compared with 1987 to 162 million gal. The value of those shipments year-to-year rose 13%. However, the unit price per gallon fell 5.4% to $13.77.

Some analysts question the veracity of data on the special-purpose category. They suspect that the price fluctuations are in part due to reporting confusion and inconsistency.

According to the Department of Labor, indexes covering both paint materials and prepared paint show that prices continued to rise in the first six months of 1989. The index for paint materials prices rose 4.4% to 133.0 (1982 = 100) between January and June, reflecting increases not only in the price of titanium dioxide, but also of solvents. In 1988 the index rose to 115.7, an increase of 7.8% over the previous year.

Prepared paint prices have not kept up with raw material price increases. Pricing is frequently viewed by the manufacturer as the key to a larger share of the market and thus greater profits. In a bid for greater share of market, paint makers often temper price increases even though raw material costs are rising faster.

Rise in paint materials prices is outpacing that of paint



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Between January and July, the index for prepared paint prices rose 3.4% to 120.3, a full percentage point below the increase in the index for raw material costs. In 1988, the index for prepared paint prices rose to 112.2, 3.8% over 1987. That increase, passed along to paint consumers, was four percentage points below the increase in the index for raw material costs.

From 1973 to 1988, paint materials prices increased about 7.9% per year. Over the same period of time, prepared paint prices have risen about 6% annually. Consequently, if prepared paint prices don't increase, either raw material prices will have to drop or paints will have to be reformulated and quality may suffer.

To meet the increase in shipments of paint in 1988, paint makers hired more employees. According to Department of Labor statistics, the total number of production and nonproduction paint industry workers rose 1.4% last year to 63,500—the same level as in 1985—compared with 1987. Still, the industry produced 69 million gal more paint than in 1985. Over the years, the paint industry has been able to produce more paint even as the level of employment has declined. Between 1979 and 1988, industry employment declined 7.4%

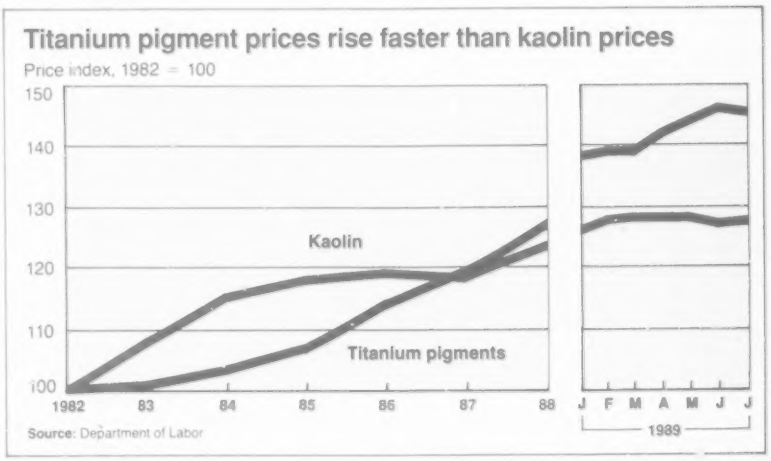
The number of both production and nonproduction workers in the industry increased between 1987 and 1988. Nonproduction employees of paint firms rose 0.6% in 1988 to 32,100; production employees increased 2.3%. However, between 1979 and 1988, employment of production employees fell 13% to 31,400. The level of nonproduction employees during this period decreased only 3.1% to 32,100.

Architectural paints' plight

The architectural coatings market is frequently viewed as mature and unexciting, with low profit margins despite high volume. But it is a market that represents opportunity, or else PPG would not be interested in purchasing the Olympic and Lucite paint lines nor would Courtaulds have made its investment in Porter Paint a few years ago.

The architectural coatings market does have drawbacks. National hardware and discount store chains use paint sales as low margin loss leaders to generate sales traffic in their stores. In the process they accustom the consumer to expect unrealistically low prices for paint, says one industry observer. Some paint producers carry architectural paint lines as a way not only to leverage their fixed costs but also to give them raw material leverage when they negotiate supplies for their entire line.

Where architectural paint lines include solvents that contribute to VOCs, manufacturers have to put a great deal of money into reformula-



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ting their products to lower VOC emissions to meet standards set principally in California, but also in New York, New Jersey, and other states. Adding to the confusion is the host of differing standards issuing from a number of air quality management districts within each state.

California has a patchwork of air quality districts that generate regulations in concert with the state's Air Resources Board in Sacramento. The board's stationary source division advises the 41 air pollution and air quality management districts on standards for reduction in air pollution that would bring a district in compliance with federal air quality standards. According to an information officer for the board, 23 districts have adopted rules affecting architectural coating VOC limits and the rules can vary from district to district. Districts cannot adopt weaker rules than the benchmark standards the state board suggests, but the rules can be more stringent. Districts, he points out, can decide not to adopt any rules at all, and 18, mostly sparsely populated, districts have not adopted any standards.

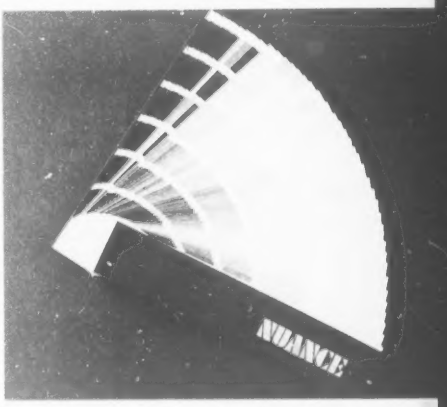
A technical document published by the Air Resources Board in July 1989 states that "statewide emissions from architectural coatings are estimated to have been 154 tons per day in 1984, which represents approximately 18% of all VOC emissions from solvent use sources in California. Architectural coatings are estimated to account for about 8% of all statewide nonvehicular emissions."

New state board standards put into effect in September by a number of air quality management districts have affected a category of specialty architectural coatings including enamel undercoatings, metal pigmented coatings, tilelike glazes, and others. These new standards would, says the state board, "reduce emissions from application of architectural coatings by about 9% in the year following adoption, and by an additional 5 to 13.5% in the fourth year after adoption. . . . These estimates are based on sales volume indicated in the 1984 Architectural Coatings survey. Since the coatings market in California has been growing, we believe actual reductions from 1988 sales volumes will be greater."

Most paint makers are confounded by the web of standards in effect. "We need uniformity for economy of scale so that research and development can be directed at achieving one and not a host of requirements," says Frederic J. Zimmerman, an attorney on the staff of the National Paint & Coatings Association.

Zimmerman says that paint manufacturers would like to see one set of national standards in effect. The opportunity to set national standards might be achieved in 1991 when the Clean Air Act comes up for reauthorization, he says.

Notes Bob Koch, vice president of trade sales for ICI's Glidden, some of the differing labeling standards required from municipality to municipality are confusing. It means contantly changing labels as new rules go into effect. "I'm for clean air, too," he says, but "these well-intentioned clean air efforts are killing us."



Hutz photo

Fan deck of architectural coatings

To meet lower VOC emissions standards, Glidden, like most others in the paint industry, have gone in the direction of developing high solids and latex-based coatings. And Koch is confident that as technology develops, paint makers will be able to drive down VOC emissions. But the confusing web of regulations has forced the company to

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Du Pont's Altamira Ti-Pure titanium dioxide plant in Mexico

scramble in certain instances. Some Glidden products are now "localized" exclusively for California, he says, and that creates a host of problems. It forces the company to carry many more products in inventory, and thereby increases its costs.

Although Glidden is not against lowering VOCs in its paint formulations, it would prefer a national standard. "There is an opportunity here for us," says Koch. Because Glidden is part of ICI's worldwide paint and coatings business, it has access to technology that would give it a competitive edge. But that leverage could only be useful if it had a national standard to which it could formulate, says Koch.

Many paint companies are formulating their products with some of the California standards as a basis. Because the state's Air Resources Board has invested so much time and effort into developing regulations, many other states look to California for guidance. And the National Paint & Coatings Association as well as individual paint producers have begun to regard California's strict VOC paint regulations as the standard against which to formulate.

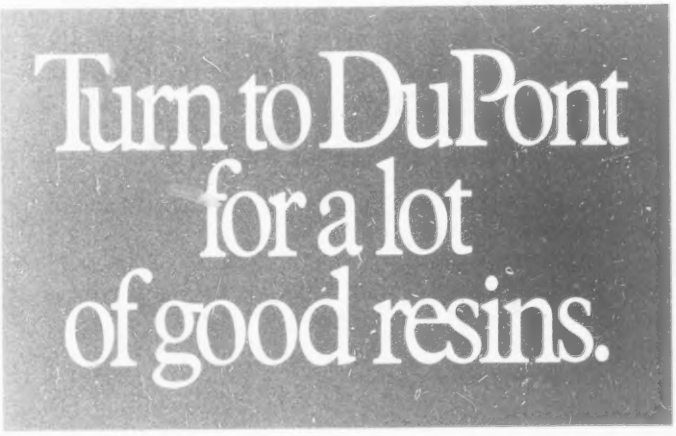
The California Air Resources Board's July 1989 technical document notes that "the primary source of air emissions from architectural coatings is the solvent component. Other ingredients in the coating may also volatize and be lost to the atmosphere but these emissions are generally trivial when compared to the solvent emissions." Reducing VOCs then takes any number of forms, including substituting mostly water reducible resins in applications where solvent and oil-type resins had been used formerly and using more active solvents to reduce higher solids paint.

In situations where coatings are applied by the consumer, as they are largely in the architectural paint classification, waterborne coatings have largely displaced solvent-based coatings. But most contractors still prefer solvent-based coatings because they can be applied over a wider temperature range, adhere better to older, chalky substrates, and are more resistant to abrasion. Where glossy finishes are preferred, oil-based formulations still predominate because they generally perform better.

Oil-based paint formulators may get a lift from recent research. According to Robert E. Perdue Jr., a taxonomic botanist recently retired from the Department of Agriculture's Agricultural Research Service, an oil derived from the seed of *Vernonia galamensis*, a plant native to Africa, can replace traditional solvents in alkyd resin paints. Based on estimated U.S. alkyd paint use of 325 million gal, paint formulated with vernonia oil could reduce VOC emissions by 20 million gal annually.

Vernonia produces seeds that contain oil, which, Perdue says, is chemically similar to epoxidized soybean and linseed oil. But unlike these oils, which are highly viscous, semisolid at 50 °F, and nonpourable below 32 °F, vernonia oil has a low viscosity and is pourable below 32 °F, he explains. As a result, vernonia has potential as a reactive diluent in alkyd paints and wouldn't, he believes, contribute any VOCs to the final paint formulation.

Eugene B. Schultz Jr., professor of engineering and applied science at Washington University, St. Louis, has begun some studies on the economic viability of vernonia oil. He describes the seed oil content as similar to that of the sunflower seed and, given existing technology, says that the extraction of the oil is not



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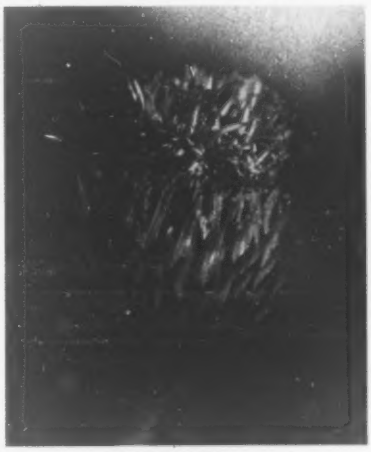
expensive. Because *Vernonia galamensis* is native to Africa and does best in semiarid tropical and subtropical regions, Zimbabwe and Kenya are the most likely areas to cultivate the plant initially.

Schultz says that the wild, unimproved germ plasm has already yielded 650 to 700 lb of oil per acre in test fields in Zimbabwe. Although it is difficult to put a cost on the oil, he believes it "probably won't be more expensive than sunflower oil."

The South Coast Air Quality Management District (SCAQMD) in California, which includes Los Angeles, has taken an interest in the potential commercialization of vernonia. The district is among the strictest in VOC standards and has put regulations into effect in advance of most other state districts. According to Larry Watkins, a program supervisor for stationary demonstration projects at SCAQMD, the district has contributed $190,000 to research in the potential commercialization of vernonia now under way at the Coatings Research Institute (CRI) of Eastern Michigan University in Ypsilanti.

USDA photos



Vernonia galamensis plant *(left) may provide oil for alkyd paints; in Africa, USDA's Perdue (above, left) inspects vernonia crop with chemist T. Nyati*

Watkins, a chemical engineer, calls the chemistry of vernonia oil "pretty sexy." He is particularly excited about it because SCAQMD sees it as a natural epoxy oil with no VOCs whatsoever. The real problem, he says, is that commercial quantities of the oil are not yet available. He sees no problem in obtaining the oil once it is produced in commercial quantities, because both Zimbabwe and Kenya have had fairly stable political climates for the past 15 years. Also, the plant has potential as a commercial crop in Colombia and Costa Rica, he notes.

Watkins thinks the oil will work in high-solids as well as low-solids alkyd formulations. He hopes that SCAQMD's funding of the CRI effort will result in the technology for paint makers to develop proprietary coatings. He says the project has no interest in developing technology to license paint formulators.

According to John C. Graham, director of CRI, a total of $425,000 has been committed for the two- to three-year research project not only from SCAQMD, but from the U.S. Agency for International Development, the state of Michigan, and Paint Research Associates, an industry-financed research authority that Graham also directs. Work already under way by a research team headed by Stoil Dirlikov, formerly of Dow Chemical and Case Western Reserve, along with two postdoctoral students and one graduate student, shows that vernonia is compatible with alkyd. The researchers hope to have more substantial information in the key area of VOC reduction within the next three to six months.

Until more is known about the performance of vernonia oil in paint formulations, paint manufacturers will have to tinker with their for-

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mulations to meet changing regulations. According to Ernest A. Hahn, director of planning and development for PPG's coatings and resin group, new VOC regulations require continual modifications in the formulation of the company's product line in an effort to maintain the quality and performance levels the public associates with PPG's label. Supplying compliant products is "an expense that we have to absorb," says Hahn, to build PPG's long-term strategy in the architectural coatings market.

Hahn notes the move in architectural paints to waterborne solvents not only helps the company produce compliant formulations, but also is advantageous in the do-it-yourself paint market where easy cleanup is a selling point. He estimates that of all architectural coatings sold, about 80% are latex and 20% are solvent formulations.

One approach to lowering VOCs in solvent coatings is replacing common diluents such as mineral spirits, toluene, and xylene with 1,1,1-trichloroethane. According to James A. Mertens, Dow project leader in the chemicals and metals division, the company's trichloroethane solvent in some cases can substitute for common diluents on a one-to-one basis "at increased cost, but it does get the VOCs down."

But Mertens cautions that substituting with trichloroethane is only a short-term solution. Those paint makers who reformulate might find it more cost effective to produce high-solids products. He also is aware trichloroethane does contribute to stratospheric ozone depletion. Its contribution, he notes, is significantly less than chlorinated fluorocarbons, which are scheduled for commercial phaseout under the Montreal protocol.

In addition, trichloroethane may be classified as a toxic air contaminant. According to the July 1989 California Air Resources Board technical support document on architectural coatings, "Manufacturers may elect to use 'exempt' solvents such as 1,1,1-trichloroethane or other halogenated compounds to reduce the VOC content of their coatings to meet the new standards. . . . [But] some of these substances (e.g.

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Product Report

Hahn: move to waterborne solvents

1,1,1-trichloroethane) may be reviewed for possible identification as toxic air contaminants. . . . Identification of a substance as a toxic air contaminant would almost certainly lead to its removal from architectural coatings."

To produce lower VOCs, paint formulators are turning to higher solids solvent coatings, and to do that they have adopted higher solvency power products. A spokesman for Eastman Chemical notes that "Eastman products such as methyl amyl ketone and methyl propyl ketone are used in compliance coatings because of their low weight per gallon and high solvency power." The Eastman spokesman also adds, "Acetylacetylation technology was introduced to the industry by Eastman and it should increase the resin manufacturer's ability to design resins for low-VOC coatings."

Du Pont is promoting its dibasic ester family of solvents for use in some solvent-based coating systems both because these solvents' slow evaporation rate "contributes less to the VOC problem," and because they are safer, low-toxic biodegradable solvents, notes J. A. Senex III, marketing manager in Du Pont's petrochemical department. Senex says that dibesic ester is also an ideal paint cleaner for use in brush and hand cleaning formulations and can be incorporated in paint removing formulations as a replacement for methylene chloride, a suspected car-

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cinogen. Senex describes the dibasic ester family as "almost a drop-in for acetone." He adds that, although it is more costly per pound than either acetone or methylene chloride, not so much dibasic ester is required in formulations in which it would displace these solvents.

Although VOC output in latex coatings isn't so great a concern as in solvent-based coatings, solvents are used in waterborne formulations. Eastman, for instance, has supplied latex paint formulators with its Texanol ester alcohol since 1962 and also markets Ektasolve EB glycol ether for use in architectural coatings as a coalescent for latex paints. Going up against Texanol is a new Exxon Chemical coalescent, Exxate 1000, that market development specialist Jackie Reynolds describes as a "pretty low-odor isodecyl acetate." Exxate 1000 will cost slightly more than Texanol, she says, but offers low odor, good freeze-thaw stability, and may require less product by volume than the Eastman agent, thereby resulting in lower unit cost. She adds that Exxate 1000 also promises to contribute fewer VOCs per unit of paint because it has low specific gravity and because it will be incorporated into paint formulations at lower concentrations.

Raw material costs on the rise

Increases in raw material prices this year also are creating headaches for paint makers. Notes a vice president in charge of purchasing for a major paint manufacturer, prices for hydrocarbon solvents have "yo-yoed" up and down as oil fluctuated between $11 and $23 per barrel this year. Prices of toluene, xylene, mineral spirits, and aliphatics have reached all-time highs during the year. Prices of titanium dioxide also reached new highs this year, though they have dropped back some. Titanium dioxide, admits one supplier, is now a "major part of paint cost aside from the can."

According to the U.S. Department of Labor, producer prices for titanium pigments increased 6.8% in 1986 from the year earlier; they rose 4.5% in 1987 and then 6.4% last year. Users had to pay an additional 5.1% for the pigment between January and July of 1989.

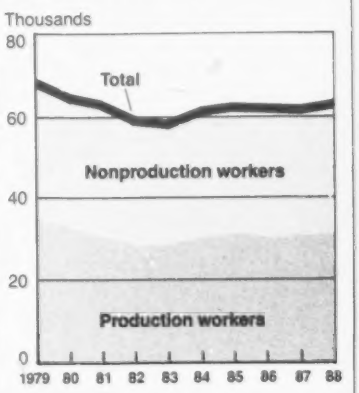
There is, however, no real substitute for titanium dioxide, says Sol Spindel. Spindel, president of New York City-based DL Laboratories, runs one of the few independent paint performance testing labs in the U.S. accredited by the National Institute of Standards & Technology. Titanium dioxide prices currently exceed $1.00 per lb, in contrast to 25 to 30 cents more than 10 years ago, he notes. Spindel says there is currently a lot of interest in technology to extend the usefulness of the dioxide in paints and he plans to chair a conference next spring on the subject.

Extender pigments have been used for years, but because of the current high price and continuing shortage of titanium dioxide worldwide, extenders such as talc, zinc oxide, and kaolin have generated more interest. "There is a variety of materials to extend TiO_2, but nothing to replace it on a cost performance basis," notes Spindel.

Prices of extender pigments also have been much more stable than those of titanium dioxide. The price of kaolin, for example, has increased only 1.2% between 1985 and 1986, according to the Department of Labor's producer price index. In 1987, the price of the processed clay product rose 0.5% compared with the year earlier, and was up 3.6% in 1988 compared with 1987. Although titanium dioxide prices continued to move up this year, kaolin prices have been relatively stable, rising only 0.8% between January and July 1989.

Over the past few years, the supply of titanium dioxide has been tight at any price. "During the last two years customers have been ordering TiO_2 months in advance just to get their allocation," notes Donald V. Borst, president and chief executive of SCM Chemicals, a titanium dioxide supplier. It is, he notes, the best opacifying agent available with the highest index of refraction of any white pigment. "Extender material can only be used to a limited extent," he notes. Mindful of the current price and supply situation, those who use extenders have to do so to get the most economical performance system. They "need to do their homework," he says, if the quality of a paint is to be preserved.

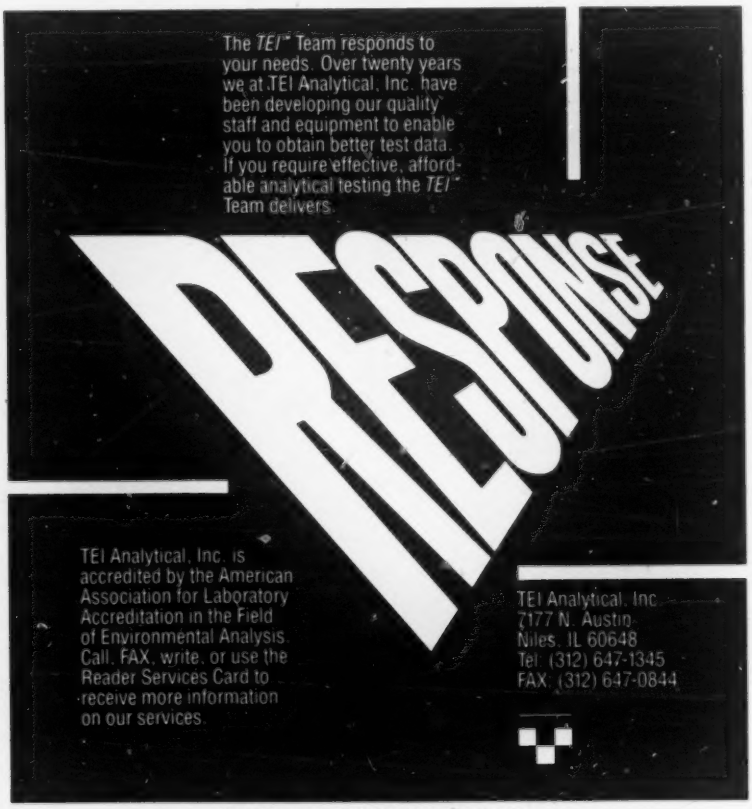
Employment edges up in paint industry



Source: Department of Labor

Prices have increased and are likely to continue to rise, notes Borst, not just because of the supply situation. Prices are up also because of environmental controls that pigment producers must install at their plants and because of raw material price increases based on the cost of ilmenite ore, which itself must be mined so as to minimize environmental impact. The supply situation is expected to ease by 1994, however, as producers have announced new projects. SCM, says Borst, plans a titanium dioxide plant in Ashtabula, Ohio, at a cost of $67.5 million with an annual capacity of 58,500 tons for startup in 1991.

Borst suggests that with the growth of global paint producing companies, there will be a need for a consistent "world grade" of titanium dioxide to supply those companies who want to make similar paint products internationally. Multiyear contracts between producers of the dioxide and users could result in guaranteed supplies and prices for the paint formulators, says Borst. They would also guarantee a market for the dioxide producer and ore miner, both of whom could then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project and amortize their investments in the titanium dioxide business with some degree of certainty.

"U.S. TiO_2 pricing is the lowest in the world," says a spokesman for Kerr-McGee's pigment division, whose Hamilton, Miss., titanium dioxide plant is rated at 106,000 tons. Higher prices overseas have led the company recently to export product for the first time. And, he adds, it will "continue to do so as the opportunity offers."

As for titanium pigment extenders, they have, admits the spokesman, filled some voids. But the extenders can only go so far. Kerr-McGee's spokesman believes they can replace, at most, only 10% of titanium dioxide.

Kaolin, contends Craig J. Stoneback, worldwide marketing director of Engelhard's pigments and additives division, is the best extender of titanium dioxide and other pigments. And William E. Nettles, group vice president and general manager of the same division, notes that Engelhard is working on new technology to extend color pigment with kaolin as well. The kaolin extender disperses titanium dioxide in a paint and improves the light scattering qualities of the dioxide, says Stoneback.

Engelhard, says Stoneback, is also providing a very fine grind kaolin to act as a titanium dioxide extender in solvent paint where traditionally the clay has not wet so well as in latex paint formulations. Prices of kaolin are more than competitive with other extender products and currently amount to 10 to 30 cents per lb. To supply paint and other markets with kaolin extenders, Stoneback says that Engelhard finished an $80 million, 300,000-ton expansion of its kaolin capacity last November.

Giving kaolin some competition as a titanium dioxide extender is an opaque polymer from Rohm & Haas called Ropaque. According to Patrick R. Colau, manager of Rohm & Haas' North American coatings business, Ropaque is a polymeric particle surrounding a water core. As the polymer dries, it leaves an air void in the center that translates into hiding power. Thus it can substitute for about 5 to 10% of the titanium dioxide in a paint formulation. Most of the opportunity for this extender is in the exterior flat paint market, says Colau. Ropaque is, he says, attractively priced relative to titanium dioxide.

Stoneback: kaolin the best extender

Use of colorants growing

In the area of color, Engelhard's Stoneback says that sales of color dispersions are growing as paint formulators increasingly leave the preparation of dispersions from dry colors to dispersion specialists. The recent incorporation of the Harshaw/Filtrol color business into Engelhard's pigments and additives division puts the company into the dispersants business. Small and medium-size paint producers have incorporated Engelhard's Gallery 1 color pigment in store additive systems for custom coloring of pretinted bases, notes Stoneback.

Hüls America, also, notes that its color dispersion business is growing. "We're superior in making colors and controlling the strength and we are able to guarantee consistency from lot to lot" to the point of providing a certificate of analysis for each batch, says John W. Du, Hüls colorants and coatings research and development manager. Jack Col-

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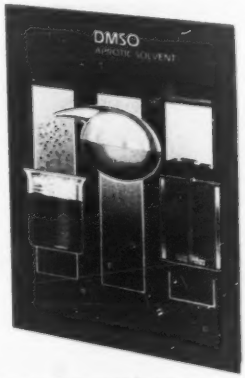

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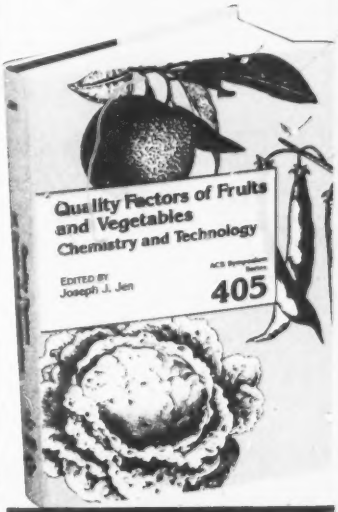
lins, Hüls director of sales, says that the company is working on and can provide new metal driers that will work in higher solids, low-VOC products that allow formulators to comply with California regulations.

In the polymer area, Rohm & Haas' Colau says that use of waterborne acrylic and vinyl acrylics continues to grow and make inroads against high-gloss alkyd solvent-based formulations. Rohm & Haas' HG74 resin is "just gaining acceptance" as a high-gloss acrylic coating for both exterior and interior use, he says. The company's Multilobe acrylic emulsion for exterior applications has been reformulated, he adds, to offer good film build without external thickeners, providing good adhesion to chalky substrates and without the difficulty in mixing some colorants as it had during its first introduction in 1987.

Mobay's Jack J. Bracco, technical marketing manager in the coatings division, says that polyurethane formulations are a natural for growth in the architectural paint market, particularly where high performance is a criterion. Where longevity is a criterion, polyurethanes ought to be used more, he says, though he admits that polyurethane formulations take only about 5% of the high-performance architectural coatings market. Waterborne polyurethane dispersions give off less VOCs in applications on concrete and metal substrates.

Also in the high-performance arena in urethane coating systems, American Cyanamid business manager Robert F. Anderson says that the company is developing uses for its aliphatic isocyanate monomer *m*-tetramethyl xylylene diisocyanate (TMXDI) as part of a high-performance roof coating system that has a foam underlay. The roof system is particularly effective in covering broad expanses, as it has a high degree of elasticity, he says. Anderson also notes that there is increased development emphasis on aqueous systems incorporating TMXDI to form good high-solids high-performance aqueous solutions.

Where high performance in exterior paint formulations is also a criterion, Ciba-Geigy says it has per-



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Joseph J. Jen, *Editor,* University of Georgia
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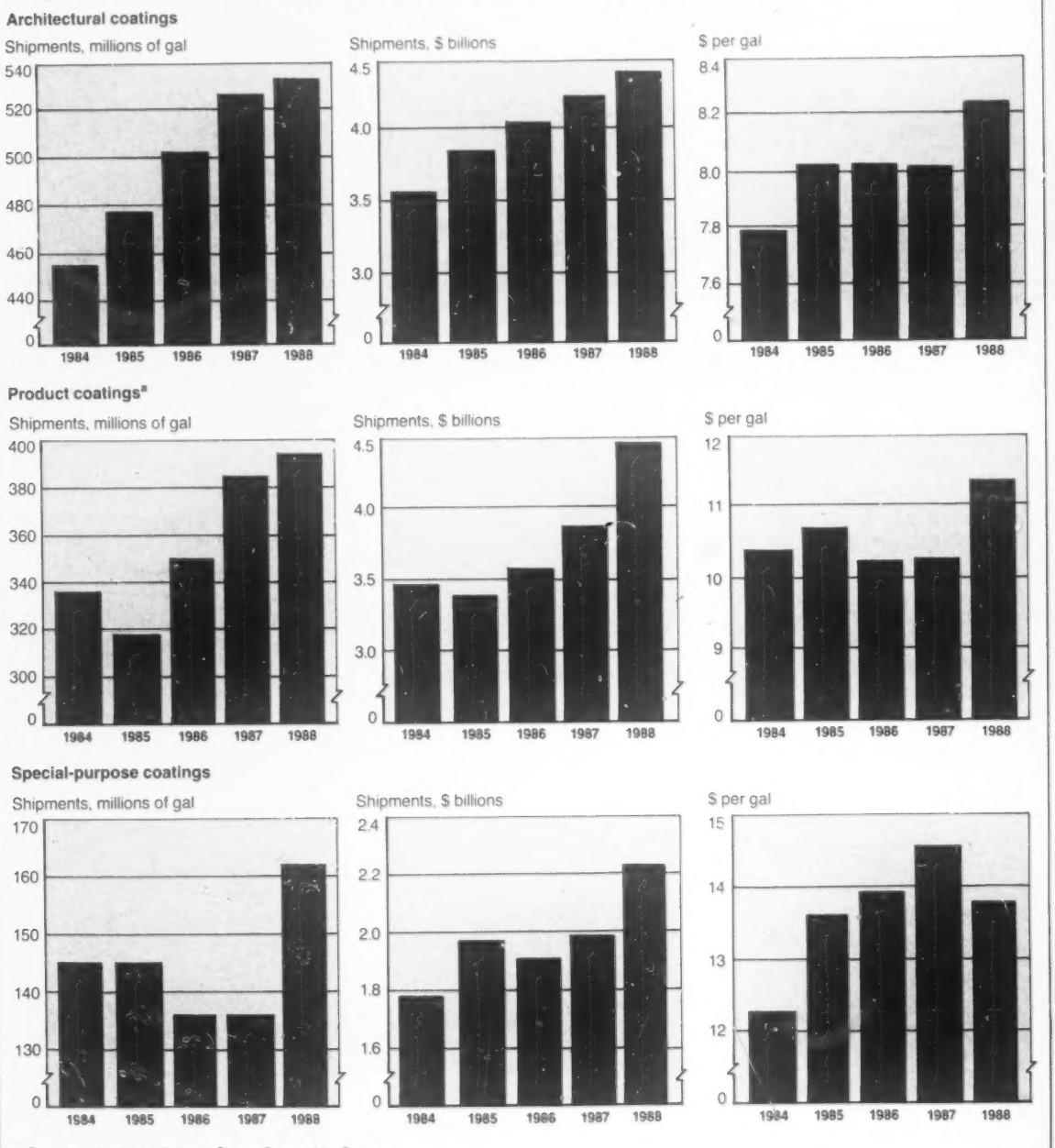

a Original equipment manufacturers. **Source:** Bureau of the Census

fected a new light stabilizer, tentatively referred to as CGL-123, for acrylic melamine, alkyd, and urethane coatings in a host of end-use markets. An adjunct to the current line of Tinuvin UV absorbers based on benzotriazoles and hindered amines, CGL-123 is based on amine ethers and bypasses the chemistry of oxidation in a paint film leading to a longer life coating, says Peter J. Schirmann, marketing and sales manager in the additives division.

The new Ciba-Geigy product likely will be commercially available soon, says Schirmann, though final cost has not been determined. Although production of CGL-123 is more expensive than standard hindered amine chemistry, Schirmann expects that final cost will still prove itself on a cost-performance basis where longer film life is desirable. □